

## ISSUES RELATED TO LINE-ORIENTED FLIGHT TRAINING

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In the next 20 minutes or so, I would like to summarize and list the major issues and specific topics for discussion that we want to see addressed and resolved at this workshop. I will begin by briefly reviewing how NASA became interested in the concept of LOFT and discuss some relevant research which was conducted in our Human Factors in Aviation Safety program. Then, I will give you an overview of some of the observations made by Clay Foushee and myself during a series of field trips to various training centers. The intent of this presentation is simply to set the stage for the industry presentations you'll be hearing later, and to give you a framework for the issues to be resolved during the individual working group meetings.

Let me just briefly, then, review for you how we became involved in LOFT. I think most of you are familiar with the study that Pat Ruffell Smith and several of us conducted several years ago (ref. #1). As you may recall, Pat was interested in studying the human factors of aircraft operations, and had some ideas about making use of a training simulator along with some carefully structured, detailed, line trip scenarios to expose crews to a specific set of operational problems similar to what they might encounter during scheduled line operations. This provided us with an excellent, controlled and repeatable way to observe line crews in a highly realistic simulation of their working environment so that we could gain a better understanding of operationally significant human factors problems and issues.

This study was very central to our involvement in the LOFT issue. Although none of us were specifically concerned with training at the time the study was conducted, it soon became quite apparent that there were some significant training issues coming from it. In the course of having run one or two crews through these full-mission simulation scenarios, we noted some potential training implications, and also received comments from the volunteer crews and from the airline people who were working with us on the program to the effect that these were, "...damn good training sessions." Pat summarized some of these observations in his final report:

"The kind of scenarios and techniques used in the experiments demonstrated to Center and training personnel how easy it is for errors to be made in a high workload situation...This has implications for training."

Pat's observation with regard to errors is a particularly relevant one for this discussion. It is one of the common themes that we see every time we start digging into LOFT and start asking flight crew members their impressions of LOFT or full-mission simulation. I think one of the major benefits to be derived from this approach to training stems from the fact that you are putting people in a highly realistic environment and they find, perhaps for the first time, how easy it is to make sometimes serious mistakes, even in fairly simple situations.

In another place in his report, Pat said that,

"...special training in resource management and captaincy [should] be developed and validated. Such training should include the use of full mission simulation of scenarios that are representative of actual situations. Special emphasis should be given to those situations where rapid decisions and safe solutions for operating problems are required."

Again, I think that Pat managed to capture an essential feature of LOFT--that it is a full mission simulation of situations which are representative of line operations with special emphasis upon situations which involve decision-making, management, and leadership.

Some of the miscellaneous comments made by our volunteer crew members illustrate these points very well. One captain came out of the simulator and said, "That was the best damn training I ever had." That took us by surprise, because, to us, he was a subject in a human factors experiment. We had not focused upon the training issue, and yet this individual apparently came out feeling that he had just received a great deal of training.

Another individual reported that he always had the philosophy that in an emergency situation, he as the captain should immediately take over control of the airplane--he's the superman who is going to save the airplane and all of the people. However, his experience in the simulator clearly taught him that that is not necessarily the best course of action, and that there are some situations where it is best to turn over physical control of the airplane to the copilot so that the captain can properly attend to more pressing matters. Again, this individual expressed the notion that he had learned a valuable lesson, which was not what we had originally intended to do in the Ruffell Smith study.

We conducted the simulator study in 1975 and early 1976. In October, 1976, the ATA's Flight Operations Committee held a meeting in Chicago at which I was invited to present a report on some of our human factors research, including Pat's study. Jerry Fredrickson from Northwest was there, and during the course of the meeting, he asked if we were aware of what Tom Nunn was doing with what they called Coordinated Crew Training. We very quickly established contact with Tom, and soon exchanged views, ideas, and data. That exchange was very helpful to us to help us understand how full mission simulation might apply to training, and also to help us sort out future research interests.

One source of data from the Northwest program was a questionnaire given to flight crews who had gone through the program. There were some interesting comments made that are illuminating in the context of this discussion and that further helped us to understand some of the training implications of full mission simulation. One question we asked on the questionnaire was, "What did you learn from LOFT?" One individual said that he had, "...learned how easy it is to compound ignorance with damned foolishness." I thought that was an interesting observation. Another individual said, "We came in on a wing and a prayer, but it was mostly our own damn fault." This comment is typical of many which indicated that crew members recognized that their own errors further compounded their problems and that most of the difficulties were, in fact, of their own making.

About a year after the ATA meeting, Dick Collie organized a seminar for all the principal operations inspectors, and others, from each of the FAA regions. Dick asked me to make a presentation about the Ruffell Smith study and the data we had received from the Northwest program. We had a good two-day exchange of views and ideas, and I find it interesting that my most vivid memory of that meeting was the sometimes-heated discussion among the participants on one of the key issues that all of us will be trying to resolve at this workshop--the issue of training versus checking.

There were other developments following that seminar, but probably the most significant for this discussion was the cockpit resource management workshop which was held in June, 1979. Resource management problems appeared to be associated with a large proportion of the errors observed in the Ruffell Smith experiment, and a considerable amount of discussion was held on the topic of LOFT as a possible method for training resource management skills (ref. #2).

That brings us to the present. Clay Foushee and I, in

anticipation of this workshop, spent some time going out to the carriers, and talking to many people on the telephone when we couldn't visit, to try to get an overview of your experience with LOFT, and to identify the major issues that you people feel should be addressed during this workshop. What I'd like to do now is to go through some of those issues that we have identified as a result of our research, discussions, field trips, and observations in the simulator.

I have summarized the major issues in the outline below. As you can see, there are four major areas of concern, and, if you've looked ahead at the agenda, you probably noticed that we have assigned a working group to each of these areas. Please bear in mind that this is not necessarily the final, definitive list of issues, but rather, represents a starting place for your discussions in the working groups.

### Some Issues for Discussion and Resolution

#### A. Scenario Design and Development Issues

1. Origin, routing, and destination
2. Abnormal and emergency conditions
3. Pacing
4. Quiet periods
5. Generalized scenarios vs detailed scripts
6. Scenario revisions and quality control
7. Scenario length and frequency
8. Categories of candidate problems

##### a. Operational problems

Cabin/passenger  
ATC  
Fueling, weight, and balance

##### b. Environmental problems

Weather, winds, temperatures  
Runways wet, icy, closed

##### c. Equipment problems

Simple vs. complex problems  
Airborne equipment problems  
Ground equipment problems

##### d. Crew problems

Cabin crew  
Flight crew--incapacitation

## B. Real-Time LOFT Operations

1. Realism
2. Pre-flight activities, briefings
3. Trip paperwork
4. Communications
5. Role of instructor
6. Use of simulator capabilities and features
7. Working around simulator limitations
8. Crew composition and scheduling
9. Inadvertent departures from scenarios
  - because of pilot/crew decisions
  - because of simulator problems

## C. Performance Assessment, Debriefing

1. Role of instructor in LOFT debriefing
2. Items for discussion
3. Self-critique vs. instructor critique
4. Training vs. checking--a critical issue
5. "Satisfactory completion"--inescapable
6. Use of video, performance data printouts

## D. Instructor Qualifications and Training

1. Number of instructors
2. Line qualifications
3. Seat/position qualifications
4. Instructor training and standardization for LOFT

## E. Other Issues

1. Other uses of LOFT

Initial, transition, and upgrade training  
Procedures development and evaluation  
Equipment evaluation

## Design and Development of LOFT Scenarios

As shown above, one of the major topics for discussion at this workshop is the question of the design and development of LOFT scenarios. Some of these issues have already been alluded to, however, I'd like to briefly mention some of the major areas of concern here.

Origination, routing and destination- How do you go about selecting departure stations, destinations, and the routing in

between? What are the factors to be considered when you begin to design a practical LOFT scenario? When you approach this issue this afternoon, remember that the objective of this workshop is to produce some practical guidelines that can be applied to meet the specific and unique requirements of individual carriers.

Abnormal and emergency conditions- How do you go about selecting problem situations to build into the LOFT scenarios? What kind of problems are best suited for LOFT? I have noted two basic kinds of problems being used in present LOFT scenarios: "simple" and "complex." "Simple" problems are those problems which appear once, are taken care of by the crew, and have no further impact on the remainder of the scenario. A good example of a "simple" problem is a hung start, or a potential hot start. Once the crew has recognized the problem and taken care of it, they can forget it for the rest of the trip.

"Complex" problems, however, are of lasting consequence. We observed a good example of a complex problem during our visits to various training centers-- a #1 a.c. bus failure on the B-727. The crew properly recognized and diagnosed the problem, and took care of the immediate items, and then continued the trip. However, upon reaching their destination, they proceeded to get themselves into a great mess because they had forgotten (and did not bother to check the book) that one of the things you lose when you lose the #1 a.c. bus is the flap position indicators. Consequently, when they started to configure the aircraft for the approach, they incorrectly decided that they had a problem with the primary flap extension system, and used the alternate flap extension system, all the while waiting for the flaps indicator to show them how much flap they had down. They finally concluded that the flaps were down, all the way down, when the captain noted that it seemed to be taking a great deal of power to stay in the sky. Well, they eventually got things sorted out, but they sure went through a lot of unnecessary steps to get there.

Again, the major question here is how to select the kinds and numbers of simple and complex problems for inclusion in a LOFT scenario. One thing to keep in mind is that if you include too many hot starts, hung starts, and similar problems on the ground, you can degrade the perceived realism of the scenario. I think it is important to keep these kinds of problems at a minimum.

Pacing and quiet periods- This is an important element of scenario design. Once you've selected the kinds of problems you want to include in a scenario, how do you decide when to insert them? Should the activity always be rapidly paced, or should there be some quiet periods in the scenario? When we did the

Ruffell Smith study, we included a fairly long period after departure where there was very little happening. These were very realistic scenarios from that point of view--a complex, and somewhat harried departure, followed by a long, uneventful climb to cruise altitude. How important is this? Are you sacrificing valuable training time by including such periods in a scenario, or does the enhanced realism increase the effectiveness of the scenario? Some balance has to be struck--what is it? How do you make these choices?

Generalized scenarios vs. detailed scripts- Another issue has to do with the level of detail at which you specify scenarios. This has some very important implications for the instructors when they conduct a LOFT scenario-- it can impact their workload, and also has implications for standardization and control. Clay and I saw examples of both kinds. Very loosely organized and structured scenarios place the burden upon the instructor as to what is to be included, and when. Another approach is to use highly detailed scenarios. One example we have seen consists of several pages of script in which all problems, expected actions, communications, radio frequencies, and other necessary details are listed. All of these events are specified along a time line so that the instructor simply has to follow the script, segment by segment from push-back to the destination gate. One thing to keep in mind when you consider this issue is how do you handle diversions and, more importantly, unexpected crew actions? To prepare a detailed scenario requires careful analysis to make sure that you anticipate the most probable crew actions. We'll discuss this problem again when we get to the issue of real time LOFT operations.

Scenario revisions and quality control- I think we should attempt to come up with some guidelines for the long-term quality control of LOFT scenarios. What procedures should be followed to ensure that scenarios are kept up to date? Are there special considerations regarding the revision of LOFT scenarios?

Scenario length and frequency- A good case can be made that LOFT should not completely replace so-called Appendix F training both in the short- and long-term. For example, currently AC 121-35 requires three hours and 20 minutes of LOFT, with the remainder of the standard four hour period reserved for other maneuvers, problems, etc. Is this a good distribution of time? Is there a better mix? What are the factors to be considered in deciding this distribution?

Similar questions apply to the long term. Is it best to use LOFT every time you bring someone back for training, or should you alternate the use of LOFT and Appendix F training? Steep

turns, approaches to stalls and other maneuvers are not (hopefully) conducted during line operations. Does occasional exposure to these kinds of maneuvers in the simulator have an important effect on pilot skill and confidence? If so, how frequently should this be done?

Categories of candidate problems- I've identified four major categories of problems which can be included in LOFT scenarios.

Operational problems- Cabin and passenger problems can provide a rich source of distractions for flight crews. For example, you're on final approach and you get a frantic call from the cabin reporting a brawl in the first class cabin-- what do you do now, Captain? ATC provides probably the richest source of operational problems--there is an almost endless variety of ATC handling problems that can be built into LOFT scenarios. Another good source of purely operational problems can be the trip paperwork--fueling, weight and balance, etc. Errors can be deliberately built into these, just as they occasionally and inadvertently happen on the line.

Environmental problems- This class of problems is obvious--anything having to do with the weather and its effects is fair game here.

Equipment problems- We have already discussed some examples of hardware problems--failures of various aircraft systems and components. Remember that ground equipment can fail too, for example, navigational aids can fail, ground power units can fail, etc. All of these could be incorporated in a LOFT scenario. What guidelines can we develop to assist the scenario designer in selecting these various problems?

Crew problems- There are also problems having to do with the cabin and flight deck crew. Communication and coordination problems can be used, as can crew incapacitation.

### Real-Time LOFT Operations

Another working group will be dealing with issues having to do with real-time LOFT operations. Once the scenario is put together, how do you properly run it in real-time? What are the important factors to be considered?

Realism, pre-flight activities, briefings, and trip paperwork- Clay and I were both impressed with the notion that realism is a very important part of LOFT. It seems to us that



what you are trying to do with LOFT is create an illusion--the illusion of being in the real world operating environment. You want your pilots to deal with the problems they will encounter in the LOFT scenario in the same way they would if they were on a line trip. In order to do that, you have to create an illusion, and to do so requires strict attention to small details. Communications, trip papers, and other small details make an important contribution to the realism of a LOFT scenario. The briefing is another important element here--making the briefing as much as possible like the routine pre-flight activities, including the dispatch process, helps to create and sustain the idea that the crew is conducting a line operation. Clay and I noted some wide variations in how the dispatch process is treated in LOFT operations.

Communications- I don't believe that anyone is actually providing background communications, although we did so in the Ruffell Smith study. We found that it made a significant contribution to the perceived realism. Even though the real-time controller's voice was clearly different from that on the background tapes (which we made by recording communications on similar trip segments), we still heard an occasional crew member say, "Was that for us?". They seemed to be so engrossed in the scenario that the differences between voices were not noticed. How important is this for LOFT training?

Role of the instructor- What is the role of the instructor in real-time LOFT operations? This is another key area that has a significant impact on the perceived realism of a scenario. Occasionally Clay and I observed an instructor who just couldn't resist the temptation to get involved, to point out a mistake, or to provide a suggestion. Every time this happens, the crew is reminded that they are in a simulator; they are in a make-believe world, not the real world. Again, I think this has a significant impact upon the effectiveness of LOFT, and for this reason, we must develop some guidelines describing the role of the instructor.

Simulator capabilities and limitations- How can you properly use the capabilities of your simulator in constructing and operating LOFT scenarios? On the other side of the coin, how can you work around the limitations of the simulator? In the Ruffell Smith study, we took advantage of a "limitation" in the motion platform (e.g., a pronounced kick in the seat when the "motion enable" button was pushed) to simulate the start of push-back with a not-so-smooth tug driver. At Northwest, Tom Nunn's people have programmed the visual system so that they can taxi anywhere on the airport, even into the gate. These details contribute greatly to the realism of the situation, and, I believe, enhance the training effectiveness of LOFT scenarios.

Crew composition and scheduling- This is an issue which has come up frequently. The question here is whether or not you must have a regular line crew member in all three seats, or whether it might be possible to substitute someone else in an emergency. This question has important logistical and economic implications, as well as raising serious questions about training effectiveness given certain crew compositions. What guidelines can we suggest which will allow sufficient flexibility, yet not adversely impact training effectiveness?

Inadvertent departures from scenarios- Regardless of how thoroughly you have planned and designed a scenario, at some point, somebody is going to make a decision you did not anticipate. It's going to happen--how should the instructor handle it? Furthermore, occasionally, the simulator is going to break. If it breaks completely, obviously you have lost some time, and maybe all of the session. If it is only a partial failure, however, these can sometimes be overcome in real time. What guidelines can we develop to handle these situations?

### Performance Assessment and Debriefing

There are several issues that have to do with the question of performance assessment, feedback and debriefing. Although LOFT is a training session and not a checking session, we still must contend with the issue of "satisfactory completion." The following issues will be addressed by working group 3.

Role of instructor in LOFT debriefing- Instructors like to be actively involved in a training session. Furthermore, they like to come into a situation as an expert with special knowledge that they want to impart to the trainees. This is one role for the instructor, but there is another role, too, and that is to serve as the manager of the training session. In this capacity, one of the principal functions of the instructor is to observe the trainees, but not to interact with them in real-time. Active participation comes during the debriefing session, when the instructor helps to provide feedback to the crew. We need to develop guidelines for the instructor. What are the significant items which should be addressed during the debriefing? What are the items that an instructor should be looking for during the course of the LOFT scenario, and how should these be built into the debriefing session?

Self-critique vs. instructor critique- Another issue we need to address is the role of self-critique in the debriefing session. Several carriers use an approach in which the first thing that happens during the debriefing session is that the captain debriefs the crew. The crew does its own self-critique first. We noticed in the Ruffell Smith study and in the data from the Northwest questionnaires that crew members seemed

frequently to come out of a LOFT session with a fair amount of insight into what they had done wrong and what could have been done differently to have avoided some of the problems that they ran into. I think this self-critique can be very important, and we need to give guidance to the instructor as to how to facilitate this process.

Training vs. checking- This is a critical issue. If you put crew members into LOFT sessions where they feel that the intent is only to administer a check, I believe you lose a lot of the potential training value of the session. Yet, at the same time, it is an inescapable fact that someone has to make a decision that the crew has performed acceptably well. The Advisory Circular specifies that the training program must be satisfactorily completed. How can the instructor make this determination? What are the guidelines? At what point should the instructor decide that additional training is required? How can the instructor determine that a lesson has been learned?

Use of video recording and performance data- I'd like to see this working group give some thought to the potential application of video or performance data recording to assist in the debriefing and performance assessment process. It is conceivable that the use of a segment of a video tape in which some specific aspect of performance during a LOFT scenario is recorded could be very helpful in showing the crew what happened and who did what to whom during the scenario. The same is true with recorded performance data. In the Ruffell Smith study, we printed out aircraft flight data at frequent intervals and then used these data to cue the crew during the debriefing. The pilots found it interesting to go back and look at their own performance, and it seemed to help them recall specific situations which they encountered during the scenario.

#### Instructor Training and Qualifications

The fourth major topic for discussion during this workshop is the question of instructor qualifications and training for LOFT operations. I indicated earlier that the role played by an instructor is different in LOFT, and it is possible that some special training and qualifications are required as well. This working group will deal with the following issues and questions.

Number of instructors- One significant issue which has been raised is the question of the number of instructors required to conduct LOFT. Are two instructors required (for a three crew aircraft), or can one do the job? What are the circumstances under which one might be sufficient? Are there special steps that should be taken if one instructor is used?

Line qualifications- Line-oriented flight training means

just that--it is a simulated line operation. That means that the people who conduct the program must have intimate knowledge of line operations. Does this require that LOFT instructors be fully line-qualified? Is it necessary for them to fly in line operations occasionally? Will observation of line operations from the jumpseat suffice to qualify an instructor for LOFT operations? In the event that one instructor is used in a three-crew aircraft, must that instructor be fully qualified in all positions? If not, is any special training required?

Instructor training and standardization for LOFT- Are there instructor training requirements unique to LOFT? How should such a training program be designed? Is there any kind of recurrent training required for LOFT instructors? What kind of quality control or standardization program is necessary to ensure that all instructors are conducting LOFT in the proper manner?

Finally, as I've indicated on the outline, there are some general issues that I would like each of you to address during your working group sessions. All of the discussion above has been in the context of LOFT in recurrent training programs. There may be other uses to which LOFT or full-mission simulation can be put. For example, we at NASA use these techniques to conduct human factors research. Other potential uses include areas like the development and evaluation of operating procedures, and the evaluation of new systems. Although we don't want to spend too much time on these other applications during this workshop, I encourage you to consider some of these and to make suggestions, comments, or raise questions, where it seems appropriate to do so.

That completes what I have to say at this point. As I said, the intent was to give you some background, to identify some of the major issues, and to give you a framework which you can use during the remainder of this workshop. What we will do now is hear from those carriers who have been using LOFT, or who have evaluated the concept, to learn what the experience to date has been. Following these industry presentations, we will split into the four working groups and spend the remainder of the workshop addressing the issues identified above.